City of Monroe 2015
Fecal Coliform Bacteria Monitoring Program

Quality Assurance Project Plan

Final
Date: February 2, 2015

Approvals

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Acknowledgements

This Quality Assurance Project Plan was prepared by Herrera Environmental Consultants, Inc., with valuable assistance from City of Monroe staff.

Introduction

The City of Monroe is located in both Woods Creek and French Creek watersheds, and provides services for about 17,000 residents. Stormwater discharges in much of the western part of the City drains to French Creek into the drainage conveyance system maintained by the French Slough Flood Control District. The eastern portion of the City is located within the Woods Creek watershed.

Water quality testing by the Snohomish County and the Washington Department of Ecology (Ecology) in the late 1990s identified high levels of fecal coliform bacteria within Woods Creek and French Creek watersheds. In the past, these high levels of fecal coliform bacteria within these watersheds were not healthy for our swimmers or people fishing or boating. Ecology also determined that dissolved oxygen levels were impaired within both Woods Creek and French Creek watersheds.

As a requirement of the Western Washington Phase II Municipal Stormwater Permit (Phase II permit), the City of Monroe has been monitoring fecal coliform bacteria levels in Woods and French Creek watersheds since 2008. For the current Phase II permit, the City of Monroe is required to evaluate previous monitoring data, determine high priority monitoring locations, and prepare a Quality Assurance Project Plan (QAPP) to conduct additional fecal coliform bacteria monitoring in 2015 and beyond.

This QAPP was developed to meet the current Phase II permit requirement in accordance with Ecology's Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology 2004), and includes the following sections:

- Background
- Project Description
- Organization and Schedule
- Data Quality Objectives
- Sampling Process Design
- Sampling Procedures
- Laboratory Procedures
- Quality Control
- Data Management Procedures
- Audits and Reports
- Data Verification, Validation, and Review
- Data Quality (Usability) Assessment

Background

Woods Creek and French Creek watersheds have historically been polluted with excessive levels of fecal bacteria pollution. Although the specific fecal sources have not been identified, many of the potential sources are believed to come from humans or human activities. Pet waste, bacteria regrowth in storm sewers, failing septic systems, sanitary-storm sewer cross-connections, and illicit discharges are all potential sources. As a result of the fecal bacteria pollution problem, Ecology worked with local municipalities to develop the Snohomish River Tributaries Fecal Coliform Total Maximum Daily Load Submittal Report (Ecology 2001) and the Lower Snohomish River Tributaries Fecal Coliform Bacteria Total Maximum Daily Load Detailed Implementation Plan, (Ecology 2003). Through these plans, Ecology established the need for water quality monitoring requirements in Phase II municipal stormwater permits issued to local municipalities that collect, treat, and/or convey stormwater.

TMDL Study Area

The Snohomish River basin drains 1,978 square miles and discharges to Possession Sound near the City of Everett. The junction of two major rivers, the Skykomish and Snoqualmie, forms the Snohomish River. The total maximum daily load (TMDL) study area includes the Quilceda Allen, Woods Creek, French Creek, Marshlands, and Pilchuck River watersheds, which drain 244 square miles of land into the mainstem Snohomish River (Figure 1). Historical land uses in the basin have been mainly agriculture and forest related, but residential and commercial development has been rapidly expanding into these areas. Increased urbanization and land development activities are impacting water quality in the basin with riparian corridor alteration, conversion of forests, inadequate retention/detention of stormwater from impervious surfaces, and poorly treated stormwater run-off.

French Creek

French Creek flows westerly for approximately 11 miles in a watershed that encompasses about 28 square miles. French Creek is a relatively large stream that drains a portion of south central Snohomish County north and west of the City of Monroe and southeast of the City of Snohomish, some of which is part of the Snohomish River floodplain. A small portion of the French Creek watershed is located within the City of Monroe, leaving roughly 89 percent of the watershed within unincorporated Snohomish County. Discharge of French Creek to the Snohomish River at about river mile 15 is controlled by a pumping station that is operated and maintained by the French Slough Flood Control District.

The lower portion of the French Creek watershed contains the flat Snohomish River floodplain where much of the stream network has been straightened and channeled for agricultural purposes. Agricultural practices and lack of stream buffers along the lower reaches of the creek are causing water quality problems. The upper three-quarters of the French Creek watershed above the Snohomish River floodplain flow over gentle, largely forested slopes. Rural development in the upper watershed has more recently become significant, increasing runoff from land clearing and residential development activities. The land uses in the upper reaches of the drainage are primarily a mix of residential development, small farms and pastures, forested areas, and equestrian centers. Commercial agriculture, dairies, and duck hunting preserves dominate the lower reaches.

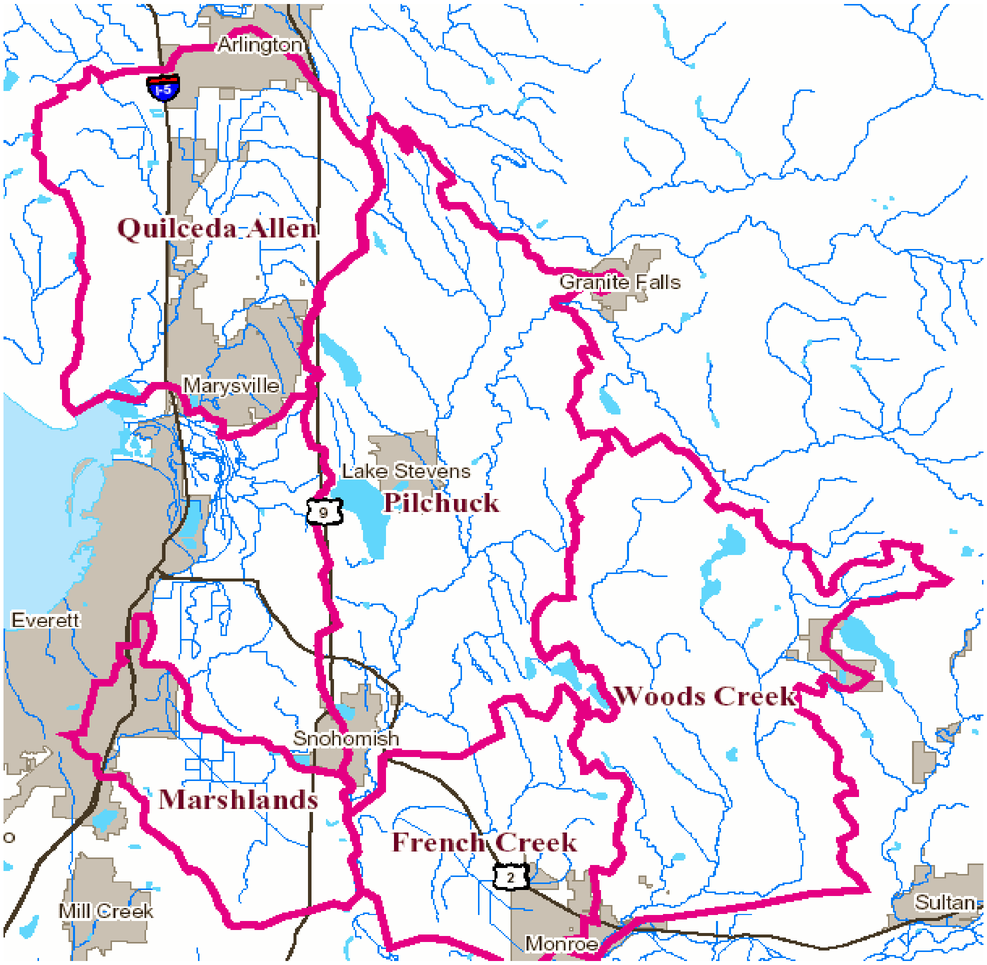

Figure 1. TMDL Study Area.

Woods Creek

Woods Creek is a large stream that flows into the Skykomish River in the City of Monroe, just upstream of the confluence with the Snoqualmie River (approximately river mile 25). Draining about 62 square miles, Woods Creek flows southerly from near Lake Roesiger entering the river at Monroe. Land use in the lower portion of the creek (around Monroe) is mostly residential and rural residential with some small-scale, noncommercial farms and several equestrian centers. Land use in the upper portion of the drainage is low-density rural residential, small farms, and tree farms. Just over 63 percent of the Woods Creek watershed is within unincorporated Snohomish County.

Pollution Sources

Pollution in both watersheds comes from both point and nonpoint sources. The point source contributions come from stormwater and include those discharges currently covered by National Pollutant Discharge Elimination System (NPDES) stormwater permits, as well as those from municipal separate storm sewer systems (MS4s) that are not currently covered by NPDES stormwater permits but meet the definition of a point source in 40 CFR 122.2. Nonpoint water pollution most commonly results from poor land use management, such as inadequate controls for agricultural runoff, failing on-site septic systems, and untreated stormwater runoff that does not come from MS4s. Where stormwater comes from rural areas it may carry wastes from domesticated animals. Stormwater from urban areas is likely to carry pet wastes to nearby streams. Urban and suburban development is continuing in the Woods Creek and French Creek watersheds, thus, water quality impacts from stormwater runoff are increasing as well.

Many areas of the watersheds have poor soils for locating on-site septic systems, which may result in failing or inadequate septic systems that contribute significant amounts of bacterial and nutrient pollutants. Some areas are still rich in wildlife, such as waterfowl, deer, and beaver. Fecal coliform bacteria originating from wildlife often comprise a substantial portion of the fecal coliform bacteria observed in streams, but are generally considered to be part of the natural background and are not considered a source of pollution.

Possible forms of pollution may include illicit discharges, pet waste, and car washing. Pet waste, other domesticated animal waste, livestock waste, failing septic systems, and sanitary-storm sewer cross-connections can all contribute fecal coliform bacteria. Plant debris, food waste, and some chemical wastes fall into a category of water pollutants known as oxygen demanding substances. All or any of the sources listed above can cause high fecal coliform counts and low oxygen levels.

Applicable Water Quality Standards

Allowable fecal coliform bacteria concentrations in Woods Creek and French Creek watersheds are designed to protect the primary contact recreational uses such as swimming. The State Surface Water Quality Standards (Washington Administrative Code 173-201A) require that water quality in these streams meet a geometric mean of 100 colony forming units per 100 milliliters (CFU/100 mL), and an upper 10^{th} percentile value not to exceed 200 CFU/100 mL (or not more than 10 percent of samples (Table 1).

Lake Tye and Lords Lake are the only recreational lakes in the City of Monroe, and they have the more stringent designation of extraordinary primary recreation. Lake Tye and Lords Lake water quality should meet a geometric mean of 50 CFU/100mL, and an upper 10^{th} percentile value not to exceed 100 CFU/100 mL. Both lakes are somewhat unique because they are used for both stormwater detention and primary contact recreation.

The State Surface Water Quality Standards (Washington Administrative Code 173-201A) also include criteria for temperature, pH, dissolved oxygen, and turbidity to protect aquatic life. Woods Creek and French Creek are designated for salmonid spawning, rearing, and migration. Numeric criteria associated with this aquatic life designation are also presented in Table 1.

Table 1. Water Quality Criteria.

Water Quality Parameter	173-201A WAC Requirements	
	Category	Numeric Criteria
Fecal Coliform	Primary Contact Recreation Extraordinary Primary Contact Recreation (Lake Tye and Lords Lake only)	Geometric mean ≤ 100 colonies/100 mL, and ≤ 10% of samples > 200 colonies/100 mL Geometric mean ≤ 50 colonies/100 mL, and ≤ 10% of samples > 100 colonies/100 mL
Temperature	Salmonid Spawning, Rearing, and Migration	≤ 16 °C for the 7-Day average of the daily maximum (7-DADM)
pH	Salmonid Spawning, Rearing, and Migration	6.5 – 8.5 units
Dissolved Oxygen	Salmonid Spawning, Rearing, and Migration	> 8.0 mg/L for the 1-day minimum
Turbidity	Salmonid Spawning, Rearing, and Migration	≤ 5 NTU with background ≤50 NTU ≤ 10% increase with background > 50 NTU

Historical Monitoring Programs

In 1996, Ecology collected fecal coliform data from the French and Woods Creek watersheds as part of the TMDL Study (Ecology 1997). Samples were collected from the City of Monroe vicinity between February and September 1996 at the sampling sites listed in Table 2. A sample location map is provided in Figure 2.

Table 2. Fecal Coliform TMDL Study Sites in the City of Monroe Vicinity

Site ID	Watershed	Latitude	Longitude	Site Name – Description
CCLS	French Creek	48.87302	-121.99049	Cripple Creel Lower – Cripple Creek on upstream side of 179th AVE SE. at Monroe boundary
CCH2	French Creek	47.87278	-122.00667	Cripple Creek at Hwy 2 – Upstream of concrete box culvert under US 2
FL1	French Creek	47.87056	-122.00833	Fryelands 1 – Fryelands Blvd, south of Hwy 2, northeast of Tye Lake, upstream of Fryelands 2
FL2	French Creek	47.86333	-122.00833	Fryelands 2 – Fryelands Blvd, north of Wales St, immediately southeast of Tye Lake
FL3	French Creek	47.85250	-122.01083	Fryelands 3 – Fryelands Blvd, south of Freylands 2 and Lords Lake at Monroe boundary
WCWF	Woods Creek	47.87615	-121.91606	Woods Creek West Fork – Woods Creek West Fork from east side of Bridge 299 at Yeager Road
WCMF	Woods Creek	47.87083	-122.91833	Woods Creek Main Fork Long-Term – Main Fork Woods Creek, York Horse Farm on Yeager Road
WCDN	Woods Creek	47.84877	-121.97010	Woods Creek Mainstem – Foot bridge crossing in Al Borlin Park

The TMDL Submittal Report (Ecology 2001) documented that fecal bacteria pollution was a significant problem in the main stem of Woods Creek and throughout the French Creek watershed in 1996. Data collected by Ecology in the vicinity of the City of Monroe are summarized in Table 3. These sampling locations indicate that fecal coliform concentrations are much lower during the wet season months from November through May than during the dry season months from June through October. The geometric mean criterion of 100 CFU/100 mL was not exceeded during the wet season at any site, but was exceeded during the dry season at all sites except lower Woods Creek (site WCDN in Monroe). However, all sampling locations in both the wet and dry seasons exceeded the site-specific target values developed by the TMDL study.

Table 3. Geometric Means and Targets for Fecal Coliform Bacteria at TMDL Study Sites in the City of Monroe Vicinity

	TMDL Study Geometric Mean (CFU/100mL)		TMDL Target Geometric Mean (CFU/100mL)	
Watershed/Site Name	Wet Season	Dry Season	Wet Season	Dry Season
French Creek, Site CCLS	<u>39</u>	**<u>394</u>**	22	67
French Creek, Site CCH2	31	**428**	NA	39
French Creek, Site FL1	<u>23</u>	**<u>407</u>**	22	64
French Creek, Site FL2	<u>71</u>	**<u>220</u>**	26	39
French Creek, Site FL3	<u>48</u>	**<u>179</u>**	46	35
Woods Creek, Site WCWF	<u>56</u>/9 [a]	**<u>160/185</u>** [a]	53/NA [a]	61/56 [a]
Woods Creek, Site WCMF	<u>45</u>/8 [a]	**<u>158</u>**/87 [a]	38/NA [a]	56/NA [a]
Woods Creek, Site WCDN	26	<u>96</u>	NA	77

Bold values exceed criterion of 100 for geometric mean and underlined values exceed site-specific TMDL target.
[a] Results of two model runs (A/B) with value A based on Snohomish County sampling data and value B based on Ecology sampling data.
NA: target not applicable due to low geometric mean of collected samples.
CFU/100mL: colony forming units per 100 milliliters.
Source: Ecology 2003

Snohomish County also monitored for fecal coliform bacteria at sample locations in the City of Monroe vicinity between 1994 and 2009. They monitored at the following TMDL sites:

- **CCH2** – Monitored between May 1995 and March 1996
- **CCLS** – Monitored between May 1994 and April 1995
- **FL1** – Monitored between May 1995 and March 1996
- **FL2** – Monitored between May 1995 and March 1996
- **FL3** – Monitored between May 1995 and March 1996
- **WCWF** – Monitored between September 1993 and December 2009
- **WCMF** – Monitored between September 1993 and November 2007

Samples from the two Woods Creek sites were also used by Ecology for comparison to the TMDL study results and development of separate target values based on models of Ecology and Snohomish County data, as shown in Table 3. Geometric means of these samples were typically lower than geometric means of the Ecology samples at these two sites.

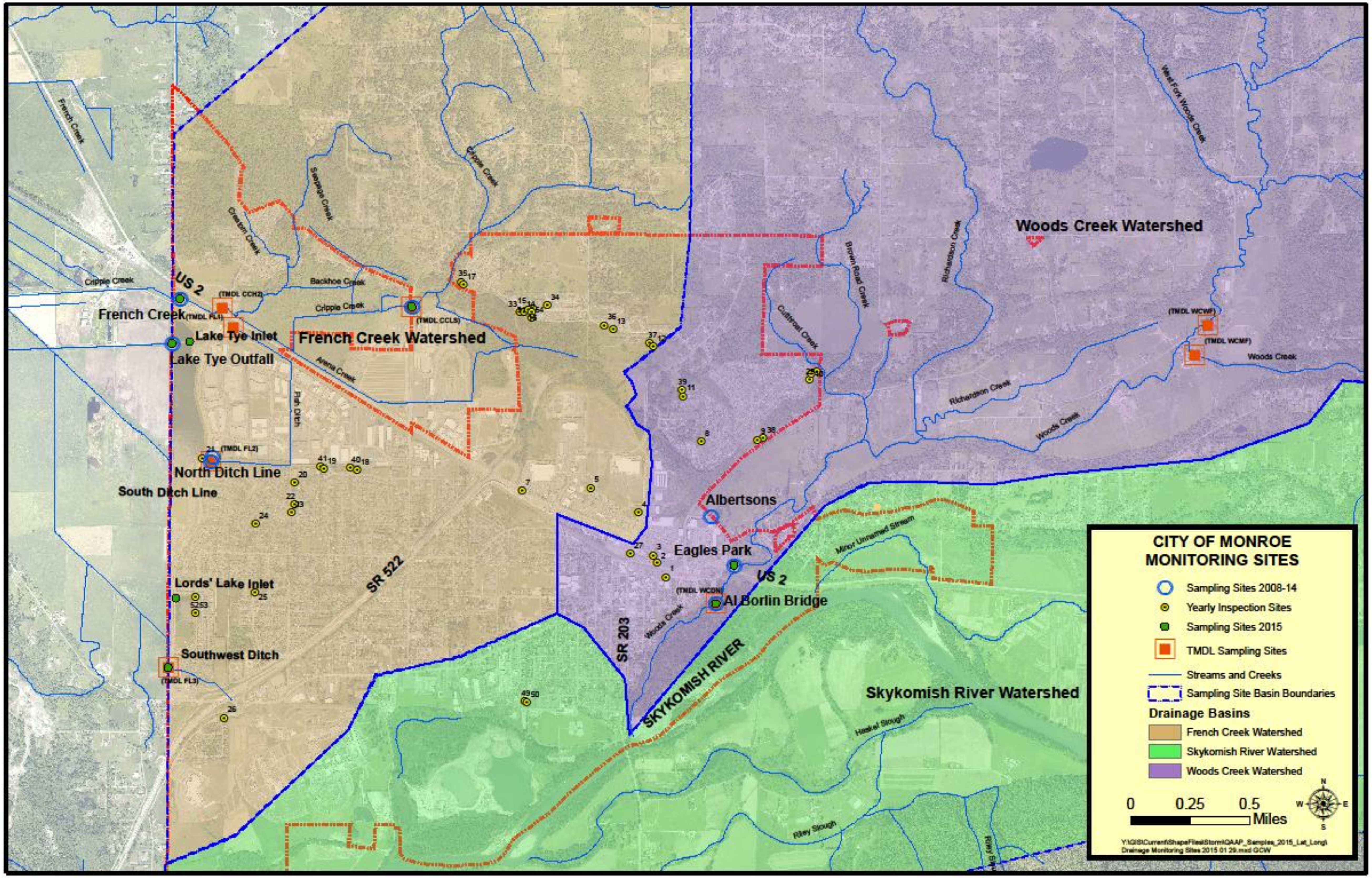

Figure 2. City of Monroe Monitoring Locations Current Monitoring Program

Program Description

The City of Monroe monitored fecal coliform bacteria at eight locations between 2008 and 2014 per the requirement of the 2007 Western Washington Phase II Municipal Stormwater Permit. A QAPP was prepared and approved by Ecology for the sampling of streams and/or discharges from stormwater conveyances within the City of Monroe (City of Monroe 2008). The goal of this monitoring program was to determine areas with the highest bacteria concentrations (high priority areas). The City of Monroe followed the Targeted Implementation Approach (Strategy A), which was included in Appendix 2 of the NPDES phase II permit.

The sites monitored are presented in Table 4 and shown in Figure 2. Sites monitored include four locations near or at a TMDL study site (CCH2, CCLS, FL2, and WCDN).

Table 4. City of Monroe Fecal Coliform Sampling Sites in 2008-2014

Site Name/ID	Watershed	Latitude	Longitude	Site Name - Description
French Creek	French Creek	48.87324	-122.01171	Lower Cripple Creek at city boundary south of Hwy 2, down from TMDL site CCH2
Cripple Creek	French Creek	47.87297	-121.99069	Middle Cripple Creek on upstream side of 179th Ave SE, at TMDL site CCLS
Lake Tye Outfall	French Creek	47.87050	-122.01238	North outlet of Lake Tye on west shore
North Ditch Line	French Creek	47.86361	-122.00860	South inlet to Lake Tye at ditch north of access road draining small area to north
South Ditch Line	French Creek	47.86331	-122.00873	South inlet to Lake Tye at ditch south of access road draining fish ditch/south, at TMDL site FL2
Al Borlin Bridge	Woods Creek	47.85512	-121.96270	Lower Woods Creek at footbridge, at TMDL site WCDN
Eagles Park	Woods Creek	47.85747	-121.96111	Storm outfall to Lower Woods Creek in Eagles Park
Albertsons	Woods Creek	47.86048	-121.96330	Storm drain located behind Albertsons, drains to Lower Woods Creek

Monitoring Results

Fecal coliform data collected by the City of Monroe between 2008 and 2014 are presented in Table 5. In addition to segregation of the collected data by wet and dry season, the data were segregated into storm and non-storm events to evaluate potential effects of precipitation and stormwater runoff on the geometric mean and 90th percentiles. Sampling dates were identified as storm events if the preceding 24-hour precipitation amount was greater than or equal to 0.20 inches. This criterion is equivalent to the qualifying storm event criterion established by NPDES permit. Precipitation amounts were based on the 24-hour total prior to the approximate sampling time of 10:00 am using hourly precipitation data for the Monroe at Fairgrounds rain gauge.

Similar to the TMDL study results, fecal coliform bacteria concentrations were much higher in the dry season (June through October) than the wet season (November through April). The geometric mean criterion (100 CFU/100 mL) was not exceeded at any site during the wet season, but was exceeded at Cripple Creek (184 CFU/100mL) and North Ditch Line (800 CFU/100mL) during the dry season. However, the geometric mean for North Ditch Line is based on only one sample value due to a lack of water or flow and, therefore, is not comparable to the criterion.

Table 5. City of Monroe 2008-2014 Fecal Coliform Data Summary

Site Name	Wet Target[a]	Dry Target[a]	All Samples	Wet Season	Dry Season	Storm Event	Non-storm Event
No. of Sample Dates	–	–	558	268	290	116	442
Geometric Mean (CFU/100 mL)							
Al Borlin Bridge	–	77	47	27	77	99	39
Eagles Park	–	–	36	18	65	**132**	27
Albertsons	–	–	21	9	40	36	18
Cripple Creek	22	67	69	<u>24</u>	**<u>184</u>**	**146**	56
French Creek	–	39	26	13	<u>49</u>	91	19
Lake Tye Outfall	–	–	7	8	7	20	6
North Ditch Line	–	–	11	9	**800**	13	11
South Ditch Line	26	39	18	10	31	38	15
90th Percentile (CFU/100 mL)							
Al Borlin Bridge	–	–	131	58	187	**486**	112
Eagles Park	–	–	**610**	**222**	**800**	**1000**	**640**
Albertsons	–	–	**373**	138	**400**	**620**	**300**
Cripple Creek	–	–	**608**	98	**852**	**1024**	**800**
French Creek	–	–	115	67	**504**	**2000**	99
Lake Tye Outfall	–	–	29	35	25	81	14
North Ditch Line	–	–	75	67	**800**	83	**333**
South Ditch Line	–	–	142	100	194	**412**	**290**

Bold values exceed 100 for geometric mean or 200 for 90th percentile, and <u>underlined values</u> exceed site-specific TMDL target.
[a] Seasonal targets from TMDL Implementation Plan (Ecology 2003).

TMDL targets were established for geometric means at two sites during the wet season and four sites during the dry season (see Table 5). The TMDL target for both the wet and dry seasons was exceeded at Cripple Creek. French Creek also exceeded the TMDL target for the dry season. However, TMDL targets are to be used only for comparative purposes because they were developed over 10 years ago and are not relevant to current loadings in the watersheds (R. Svrjcek, Ecology, personal communication).

The 90th percentile criterion (200 CFU/100mL) was exceeded at one site during the wet season (222 CFU/100 mL at Eagles Park) and at the following five sites during the dry season: Eagles Park (800 CFU/100 mL), Albertsons (400 CFU/100 mL), Cripple Creek (852 CFU/100 mL), French Creek (504 CFU/100 mL), and North Ditch Line (800 CFU/100 mL). No TMDL targets were established for the 90th percentile.

Geometric means and 90th percentiles were consistently higher for storm events than non-storm events with the exception of the 90th percentile for North Ditch Line (see Table 5). This comparison clearly shows the importance of stormwater runoff as a source of fecal coliform bacteria.

Temporal trends in City of Monroe fecal coliform data were evaluated using seasonal Mann Kendall trend tests. In these tests, the month of the year was used to define the "seasons". Dry season, wet season, and all data were evaluated separately based on an alpha level of 0.05 (α=0.05). The only significant trends observed were decreasing concentrations during the wet season at Albertsons (p=0.04) and French Creek (p=0.04). No significant trends were observed for the dry season or the entire sampling period. Thus, no significant changes in fecal coliform concentrations were observed at the 8 sampling sites over the past 7 years from 2008-2014 with the exceptions noted above.

Table 6 compares geometric means for 2008-2014 study to the 1996 TMDL study for the four sites sampled by both studies. This comparison shows that fecal coliform bacteria concentrations substantially decreased since the TMDL study with only one exception for the Al Borlin Bridge site during the wet season. These results indicate that fecal coliform bacteria sources in the City of Monroe substantially decreased between 1996 and 2008.

Table 6. Comparison of Fecal Coliform Bacteria Results of the 1996 TMDL Study to the 2008-2014 City of Monroe Study

Monroe - Ecology Site Name	TMDL Study Geometric Mean (CFU/100mL)		City of Monroe Geometric Mean (CFU/100mL)	
	Wet Season	**Dry Season**	**Wet Season**	**Dry Season**
Al Borlin Bridge – Site WCDN	26	96	27	77
Cripple Creek - Site CCLS	39	**394**	24	**184**
French Creek - Site CCH2	31	**428**	13	49
South Ditch Line - Site FL2	71	**220**	10	31

Bold values exceed criterion of 100 for geometric mean and underlined values exceed site-specific TMDL target.
NA: target not applicable due to low geometric mean of collected samples.
CFU/100mL: colony forming units per 100 milliliters.

Project Description

The current Phase II Permit includes a requirement for Permittees to review the fecal coliform data collected from a TMDL study area in accordance with the Ecology-approved QAPP prepared for the 2007 Phase II Permit. The purpose of this review is to identify a minimum of one high priority area to focus fecal coliform bacteria source identification and elimination efforts during the current permit cycle. Permittees are then required to submit a QAPP for fecal coliform bacteria monitoring to Ecology by February 2, 2015.

This QAPP was prepared to include evaluation of the data from 2008 through 2014, identification of a least one high priority area within the City of Monroe, and selection of locations for future sampling to identify fecal coliform bacteria sources within the priority area(s). As described below in the Sampling Design, sampling sites were retained, added, or terminated for future sampling based on the existing data evaluation. This evaluation identified Cripple Creek as the priority site based on geometric means, but upstream sampling to identify sources is not recommended because its entire drainage basin is located outside the City of Monroe. Alternatively, drainage areas of concern were identified where fecal coliform bacteria sampling has not been recently performed.

Four sites were retained for continued long-term trend analysis of major water resources, including include Woods Creek (Al Borlin Bridge), French Creek (French Creek), Cripple Creek (Cripple Creek), and Lake Tye (Tye Lake Outfall). One site (Eagles Park) was retained for continued tracking of potential illicit discharge of sanitary waste that had previously been identified using fecal coliform data. Three sites were terminated due to a lack of observed fecal coliform bacteria sources (Albertsons and South Ditch Line) or lack of flow during the dry season (North Ditch Line). Three new sites were added based on data gaps, land use observations, or areas with suspected fecal coliform bacteria sources. The sampling design also includes the potential to add more sites if priority areas are identified thorough observation or data evaluation.

The primary goal of the City of Monroe 2015 fecal coliform bacteria monitoring program is to provide sufficient data for long term trend and source evaluations of fecal coliform bacteria in stormwater and surface waters within the City of Monroe.

Organization and Schedule

City of Monroe staff will be responsible for the collection of field data and water samples during the monitoring program. They will also be responsible for analyzing the samples and reporting data in annual summary reports. The City of Monroe Water Quality Laboratory will be responsible for the analysis of water samples for fecal coliform bacteria. Roles and responsibilities of staff involved in this project are summarized below in Table 7.

Table 7 - Roles and Responsibilities for TMDL-related Monitoring

Name/Address	Title	Responsibilities
Vince Bertrand 806 West Main Street Monroe, WA 98272 Phone # (360) 863-4552 Email: vbertrand@monroewa.gov	Project Manager City of Monroe	Responsible for overall project supervision and for preparation of QAPP, project design, collecting and analyzing data, and providing data summary and narrative evaluation for the data in annual report TMDL summary. Responsible for maintaining supplies, transporting samples, recording and organizing bacteria data on an annual basis.
Brad Feilberg 806 West Main Street Monroe, WA 98272 Phone # (360) 863-4552 Email: feilberg@monroewa.gov	City Engineer City of Monroe	Responsible for reviewing and editing QAPP.
Rachel McCrea 3190 160th Avenue SE Bellevue, WA 98008-5452 Phone # (425) 649-7263 Email: rmcc461@ecy.wa.gov	Municipal Stormwater Permit Manager Department of Ecology NWRO	Primary contact with Ecology for municipal stormwater permit issues. Responsible for technical assistance to Monroe.
Ralph Svrjcek 3190 160th Avenue SE Bellevue, WA 98008-5452 Phone # (425) 649-7165 Email: rsvr461@ecy.wa.gov	Water Cleanup Specialist Department of Ecology Water Quality Program	Water cleanup specialist. Primary contact with Ecology for Total Maximum Daily Load (TMDL) issues. Responsible for technical assistance to Monroe and review/approval of QAPP.
Linda Gleason 806 West Main Street Monroe, WA 98272 Phone # (360) 794-6558 Email: lgleason@monroewa.gov	Laboratory Analyst City of Monroe Water Quality Laboratory	Performs laboratory analysis of samples. Responsible for maintaining supplies and equipment, and for data validation and reporting data results to Project Manager.

The following schedule is proposed for this permit period:

Prepare Draft QAPP for internal review:	January 22, 2015
Submittal QAPP to Ecology for approval	February 2, 2015
Begin sampling at proposed locations	March 1, 2015 (or earlier)
Prepare annual report	March 31, 2016, and annually thereafter
Submit data to Ecology's EIM database	May 31, 2016, and annually thereafter

Limitations: There are no known limitations imposed on the proposed schedule by factors such as weather, seasonal conditions, and equipment availability. However, such limitations will be addressed accordingly if they occur. Flows in the Woods Creek and French Creek watersheds are known to get very high at times; however, only the most dramatic conditions are expected to have any potential effect on the sampling program. Should problems develop they will be reported through annual BPRP/SWMP reporting.

Data Quality Objectives

The overall data quality objective is to ensure that data of a known and acceptable quality are obtained. All measurements will be performed to yield consistent results that are representative of the media and conditions measured. Data quality objectives (DQOs) are defined by precision, bias, representativeness, completeness, comparability, and reporting limits. Project-specific DQOs are provided below in Table 8.

Table 8. Summary of DQOs.

Analysis	Matrix Spike (%R)	Duplicate (RPD)	Control Sample (%R)	Reporting Limits/Units
Field Analysis				
Temperature	NA	NA	NA	+0.2 °C
Dissolved Oxygen	NA	NA	NA	+0.2 mg/L
Laboratory Analysis				
Fecal coliform bacteria	NA	RPD ≤ 35%	NA	1 CFU/100mL

%R percent recovery
CFU/100 mL colony forming unit per 100 milliliters.
NA not applicable.
RPD relative percent difference.

Precision

Precision will be assessed based on the analyses of laboratory and field split samples. One laboratory duplicate and one field split sample will be analyzed with each batch of samples. In this case, a batch represents the eight samples collected during one sampling event.

Two levels of precision for duplicate analyses will be evaluated using reported values for parameters of concern. The relative percent difference (RPD) of laboratory duplicates will be less than or equal to 35 percent for fecal coliform bacteria for values that are greater than 5 times the detection limit, and ± 2 times the detection limit for values less than or equal to 5 times the detection limit.
Precision in these samples will be quantified based on their relative percent difference (RPD):

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2)/2}$$

Where: RPD = relative percent difference
C1 = larger of two values
C2 = smaller of two values

Specific DQOs for laboratory and field splits are defined by analysis method in Table 8.

Bias

Bias will be assess based on analysis of method blanks.

Representativeness

Sample representativeness will be ensured by employing consistent and standard sampling procedures identified in the QAPP.

Completeness

Completeness will be assessed based on the percentage of specified samples collected. The completeness goal shall be 95 percent. Completeness for acceptable data is defined as the percentage of acceptable data out of the total amount of data generated. Acceptable data is either data that passes all QC criteria, or data that may not pass all QC criteria but has appropriate corrective actions taken.

Comparability

Standard sampling procedures, analytical methods, units of measurement, and reporting limits will be applied in this study to meet the goal of data comparability. The results will be tabulated in standard spreadsheets to facilitate comparison with other study results and water quality threshold limits (e.g., WAC 173-201A).

Reporting Limits

The fecal coliform bacteria analysis reporting limits and resulting methodology have been chosen so that data collected for this study is accurate and can be compared to historical data collected in the TMDL area. The range of reporting values is dependent on the sample dilutions utilized. Filter volumes will be adjusted depending on whether samples are collected after a non-storm or storm event. Two filter volumes per sample event type (10 and 100 mL for non-storm events, and 5 and 50 mL for storm events) will be used for each analysis to ensure that a broad range of concentrations can be characterized. The lower reporting limit for fecal coliform bacteria enumeration analysis will be 1 or 2 CFU/100 mL (for 100 mL and 50 mL volumes, respectively), and the upper reporting limit will be 2,000 or 4,000 CFU/100 mL (for 10 mL and 5 mL volumes, respectively),. At the discretion of the laboratory analyst, sample dilution volumes may be adjusted if bacteria concentrations differ from those anticipated.

Sampling Process Design

The project objectives of detecting trends and comparing results to the state water quality standard require collecting samples regularly at the same stations over a long time span. This approach will provide randomly collected data for unbiased analysis in the future. No attempt will be made to avoid sampling due to weather or other environmental conditions unless the safety of staff is involved.

Sampling related to the TMDL is limited to fecal coliform bacteria analysis. For informational purposes, monitoring of temperature and dissolved oxygen (DO) will also be conducted. However, these additional parameters are not required by the Permit. Standard operating procedures or guidance on the collection of these field parameters is included in the next section (Sampling Procedures) of this document.

If high priority areas are identified in the future, the City of Monroe will add additional sampling locations. On an annual basis, an evaluation will be performed to determine if source tracking is needed. A QAPP addendum will then be prepared to describe this additional monitoring.

Each existing sampling site was evaluated based on comparison to water quality criteria and representativeness within the City of Monroe watersheds. In addition, sites with known or suspected pollution sources were considered for monitoring. Current (2008-2014) and future (2015) monitoring locations are shown on Figure 2. As indications of potential pollution sources, land use zoning is shown in Figure 3 and septic system locations are shown in Figure 4.

As shown in Figure 3, land use zoning within the City of Monroe primarily consists of residential and commercial areas, with an industrial area located in the northwestern portion of the City (south of Highway 2) and open space primarily located in the southern portion of the City (adjacent to the Snohomish River).

Table 9 compares land use for areas within the City draining to French Creek and Woods Creek, and compares that to areas also draining from upstream portions of the watersheds. A much larger portion of the City of Monroe drains to the French Creek (2,320 acres) than Woods Creek (766 acres). Comparison of the two watersheds within the City shows more industrial (10 percent) and open space (29 percent) land use in the French Creek watershed, more commercial (18 percent) and residential (66 percent) land use in the Woods Creek watershed, and no rural or agriculture land use in either watershed. Inclusion of areas upstream of the City shows more rural (72 percent) and agriculture (9 percent) land use in the Woods Creek watershed compared to the upper French Creek watershed(27 percent rural and no agriculture). This land use comparison indicates that sources of fecal coliform bacteria upstream of the City may include livestock, large domesticated animals, and septic systems that are generally not present within the City of Monroe.

The map of sewer systems (Figure 4) includes color coding for the year the system was installed to distinguish old systems (yellow to red) installed before system design requirements improved in the early 1990s to include more vertical separation and less potential for failure. As shown in Figure 4, there are relatively few septic system sites located within the City of Monroe compared to upstream portions of the watershed. Furthermore, it is likely that many of those systems within the City of Monroe have not been used since those properties were connected to the sanitary sewer system.

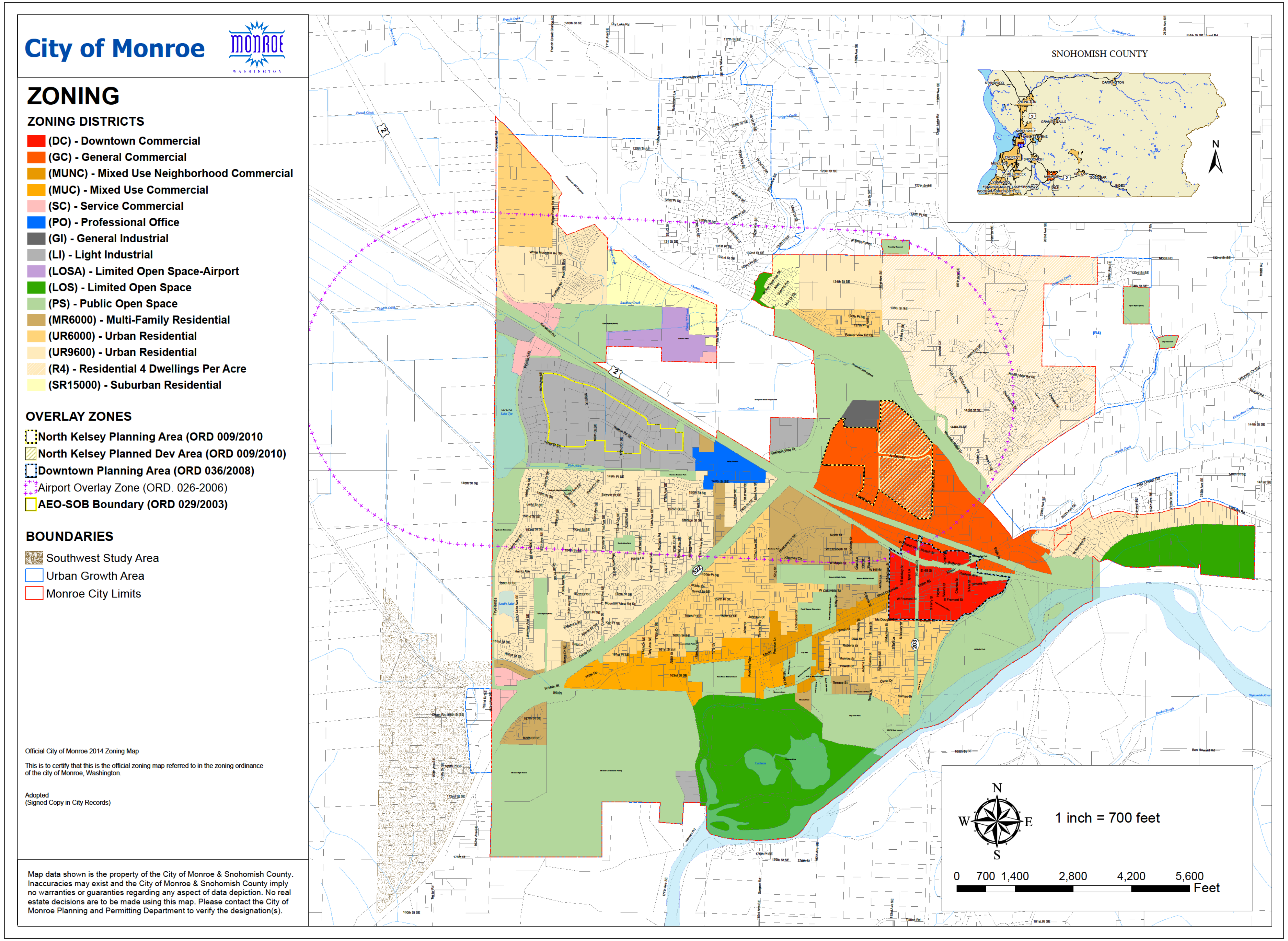

Figure 3. City of Monroe Land Use

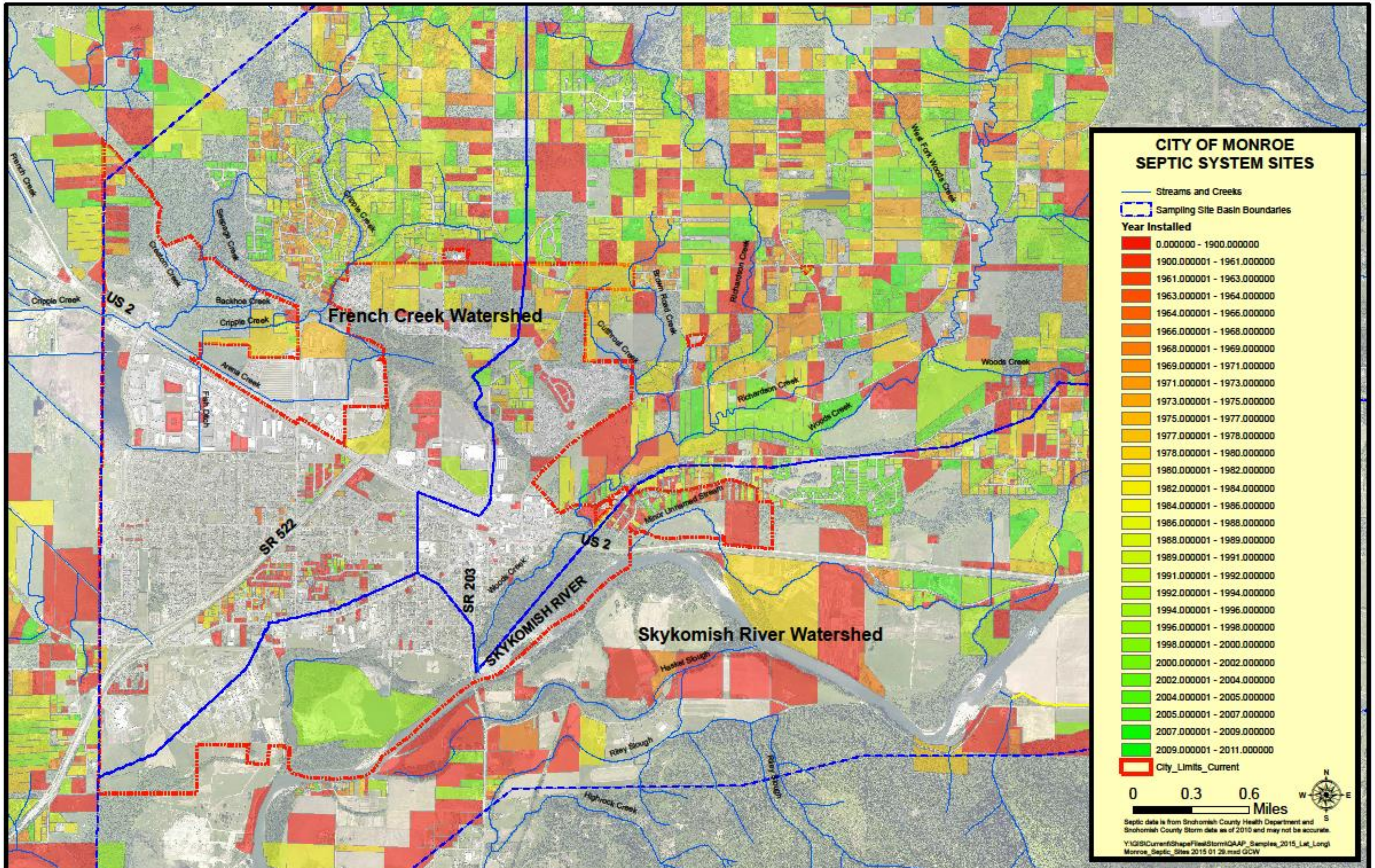

Figure 4. City of Monroe Septic System Sites

Table 9. Basin Area and Land Use by Watershed for within the City of Monroe and Including Upstream Portions

Basin Area and Land Use	French Creek[a]		Woods Creek[a]	
	Within City	Plus Upstream	Within City	Plus Upstream
Basin Area	2,320 acres	3,929 acres	766 acres	7,765 acres
Commercial	12%	7%	18%	2%
Industrial	10%	6%	0%	0%
Residential	50%	43%	66%	9%
Rural	0%	27%	0%	72%
Agriculture	0%	0%	0%	9%

[a] Watershed basin located within the City and including upstream portions.

Based on the land use and septic system maps, potential sources of fecal coliform bacteria within the City of Monroe are likely to primarily include stormwater runoff from developed areas. Although septic systems appear unlikely to be a major source within the City, human sources of fecal coliform bacteria may include cross-connections between the sanitary system and stormwater drainage system within developed areas of the City. Other sources likely include fecal waste from pets (dogs and cats) and wildlife (birds, waterfowl, rodents, and other small mammals) located throughout the City.

Based on the land use conditions and existing data evaluation, sampling sites were retained, added, or terminated for design of the future sampling program. The following five existing monitoring sites will be retained:

- **French Creek** – Retain because the dry season TMDL target was exceeded, and it is at a former TMDL site on a large stream that is useful for tracking future long-term trends
- **Cripple Creek** – Retain because the geomean standard was exceeded for the dry season, the wet and dry season TMDL targets were exceeded, and it is at a former TMDL site on large stream that is useful for tracking future long-term trends
- **Lake Tye Outfall** – Retain even though low fecal coliform bacteria concentrations were observed (well below the standard and dry season TMDL target for French Creek) because data are useful for documenting conditions in an important lake used extensively for primary contact recreation
- **Al Borlin Bridge** – Retain even though the standard and dry season TMDL target were met because it is at former TMDL site on a large stream (Woods Creek) that is useful for tracking future long-term trends
- **Eagles Park** – Retain even though low fecal coliform bacteria concentrations were observed (meets standard and dry season TMDL target for Woods Creek) because of a historical problem with sewage spilled during routine pumping into trucks at a school site located in the basin

The following three existing monitoring locations will be terminated:

- **North Ditch Line** – Terminate due to the low fecal coliform bacteria concentrations observed in the wet season (meets standard) and the dry or stagnant conditions during dry season

- **South Ditch Line** – Terminate due to the low fecal coliform bacteria concentrations observed (meets standard and the wet and dry season TMDL targets)
- **Albertsons** – Terminate due to the low fecal coliform bacteria concentrations observed (meets standard and dry season TMDL target for Woods Creek)

The following three monitoring locations will be added:

- **Lake Tye Inlet** – Add to identify fecal sources in previously unmonitored area draining to high use lake
- **Lords Lake Outfall** - Add to identify fecal coliform bacteria sources in previously unmonitored area draining to small lake and to document conditions in lake used extensively for contact recreation
- **Southwest Ditch** - Add at TMDL site not monitored in 2008-2014 to identify TMDL target compliance and potential fecal coliform bacteria sources in drainage from Monroe Correctional Complex (three violations from sewage spills) and residential/commercial properties

The Phase II Permit indicates that upstream tributaries to French and Woods Creeks are included in the TMDL Area requirements. However, no monitoring sites upstream of French and Woods Creeks are included because these upstream areas are outside of the City of Monroe limits. The City of Monroe will coordinate with Snohomish County to share results of fecal coliform bacteria tracking by Snohomish County outside the City of Monroe’s jurisdiction.

Sample Locations and Schedule

The City of Monroe will perform field parameter (DO and temperature) measurement and fecal coliform bacteria sampling at eight locations (Table 10). Sampling will occur at the same time during the first week of every month for the duration of the permit cycle.

Reporting Results

A summary report will be prepared annually as part of the Stormwater Management Plan Annual Report. The first report is due March 31, 2016 and subsequent reports are due annually on that day thereafter. Seasonal analysis of the data will be performed for the annual reports.

Sample Disposal

City of Monroe Laboratory will be responsible for disposal of the water samples analyzed in the required regulatory manner.

Table 10. City of Monroe Fecal Coliform Sample Sites for 2015

Site Name/ID	Watershed	Latitude	Longitude	Site Name - Description
French Creek	French Creek	48.87324	-122.01171	Lower Cripple Creek at city boundary south of Hwy 2, down from TMDL site CCH2
Cripple Creek	French Creek	47.87297	-121.99069	Middle Cripple Creek on upstream side of 179th Ave SE, at TMDL site CCLS
Lake Tye Outfall	French Creek	47.87050	-122.01238	North outlet of Lake Tye on west shore
Lake Tye Inlet[a]	French Creek	47.86331	-122.00873	North inlet (open ditch line) of Lake Tye on east shore.
Lords Lake Outfall[a]	French Creek	47.85495	-122.01166	Lake outlet at northwest corner of Lords Lake, in between the weir and vault
Southwest Ditch[a]	French Creek	47.85235	-122.01227	East side of Fryelands Blvd at city boundary
Al Borlin Bridge	Woods Creek	47.85747	-121.96111	Lower Woods Creek at footbridge, at TMDL site WCDN
Eagles Park	Woods Creek	47.85747	-121.96111	Storm drain located behind Albertsons, drains to Lower Woods Creek

[a] Sample site added for 2015; other sites sampled since 2008.

Sampling Procedures

Water sampling well be conducted at eight locations in the French and Woods Creeks watersheds. Downstream samples will be collected before upstream samples to minimize the possibility of collecting fecal coliform from sediments that may have been disturbed during sampling activities. Samples will be collected in the following order (from east to west, then south across the City of Monroe):

- Al Borlin Bridge (field split and duplicate location)
- Eagles Park
- Cripple Creek
- French Creek
- Lake Tye Outfall
- Lake Tye Inlet
- Lords Lake Outfall
- Southwest Ditch

Field Forms are provided in Appendix A.

Planning

Bacteria samples will be analyzed the same day as collection. Therefore, coordination between the Project Manager and Laboratory Analyst to schedule monthly sample events must be performed. The City of Monroe Water Quality laboratory will provide sterilized sample containers and a calibrated DO meter for each event.

Field Procedures

Ambient water quality samples collected as part of this QAPP will generally use the "dipping method." The dipping method is intended to collect the most representative sample taken at a single point in time (also called a grab sample).

Field measurements and comments are recorded on the field form provided in Appendix A. All field notes will be stored together in a safe location after each sampling event. Project name, station location, date and time of sample collection, field measurements, and any observations will be recorded.

A word about safety: Safety is a primary concern whenever working in or near waterbodies. Many times sampling locations are sited close to roadway crossings to facilitate access in right-of-ways and to reduce travel times to the actual sample site. In these cases, the need for life vests, reflective clothing, orange marking cones, and flashing lights should be considered to protect you in the event of a fall into the water, and to alert fellow drivers to your presence on the roadside.

Field Parameters

A YSI Model 55 handheld DO meter will be used to collect monthly DO and temperature readings at each of the sample locations. The City of Monroe Laboratory Analyst will calibrate the meter for DO per manufacturer's specifications prior to each sample collection event. Calibration procedures are provided in Appendix C.

Fecal Coliform Sampling

The general procedures for taking a proper fecal coliform sample are as follows:

1. A labeled, sterilized polypropylene sample container provided by the City of Monroe laboratory will be used. The minimum sample size is 250 mL; for field split samples, a 500 mL container will be used.
2. A sample pole may be used for reaching the thalweg quickly and conveniently (such as a boat hook fashioned with a buret clamp or two hose clamps fastened to the end of the pole.) Caution will be taken not to contaminate the pole with sediments or other substances that increase the likelihood of contaminating the sampling process.
3. For sites that may require entering the stream, care will be taken to not stir up sediment. The site will be approached from downstream in all possible cases. Where this is not possible, the flow will be allowed to dissipate any stirred up sediment before proceeding to sample. The sample will be collected facing upstream, preferably in the portion of the channel with predominant flow.
4. The bottle will be uncapped, leaving the aluminum foil on the cap. Care will be taken so as not to contaminate the inside of the bottle, cap, or aluminum foil with the sampler's fingers, dirt, water dripping from bridges, or other sources.
5. The bottle will be inverted and plunged mouth down through the surface to a depth of 15 to 30 cm (6 to 12 inches) at mid depth of stream where feasible. While under water, the mouth of the bottle will be rotated into the current and brought upright back through the surface. Enough water will be poured off until the water level is at the shoulder of the bottle. This allows room for mixing the sample before analysis at the lab.
6. The bottle will be recapped and placed on ice upon reaching shore or the vehicle.
7. Other notes:
    - The bottle should never be rinsed.
    - Water should never be poured into the fecal bottle from another container.

Field Quality Control

Field split samples and field duplicate samples will be collected for each sampling event from the Al Borlin Bridge location.

A field split sample will be collected for each sampling event using a 500 mL sample container.

To collect the field duplicate, a second bottle will be plunged side-by-side with the regular sample. If using a pole to collect samples, it may not be possible to collect the samples side-by-side. In this case, the field duplicate will be collected as soon as possible after the initial sample. A comment in the field notes will indicated if the samples are not collected side-by-side.

Sample Containers

A sterile 250 mL (500 mL at Al Borlin Bridge) polypropylene bottle will be used for all samples collected. The bottle be empty, with no sodium thiosulfate or other dechlorinating agents. Sample bottles will be autoclaved with caps covered in aluminum foil by the City of Monroe laboratory.

Sample containers will be used within one month of sterilization.

Field Processing

No field processing is required.

Sample Storage

All samples will be placed in an ice chest with crushed or cube ice immediately. The temperature should be between 0°C and 4°C. Samples will be stored in the dark. For chain-of-custody procedures, the vehicle must be locked whenever it is not in view of sampling personnel.

Holding Time Before Testing

The culturing of samples will take place as soon as possible. Standard Methods (APHA, AWWA, and WEF, 1998) recommends a maximum holding time of eight hours for microbiological samples (six hours transit and two hours laboratory processing) for water tested for compliance purposes. However, samples will be analyzed immediately upon receipt at the laboratory, which is typically less than eight hours from collection.

Chain-of-Custody and Labels

All samples will be under the city of Monroe's custody since they will be:

- In the project manager's and/or the laboratory's physical possession
- In the project manager's and/or the laboratory's individual's sight, or
- Secured in an area of the laboratory that is restricted to authorized personnel

Elements of chain-of-custody include:

- Sample identification
- Security procedures
- Field forms/log book

Proper labeling requires using waterproof tape and waterproof inks. Labels will include the sample location name.

Sample seals and custody tape will not be necessary since the samples will be transported to the laboratory immediately after collection by the project manager, who will collect the samples.

Laboratory Procedures

The laboratory procedures for sample analysis and sample quantification are described below. An example of a Laboratory Worksheet is provided in Appendix A.

Sample Analysis

Laboratory analyses for fecal coliform bacteria will be performed by the City of Monroe laboratory, which is accredited by the Washington State Department of Ecology. The analytical method to be used is described by Standard Methods for the Examination of Water and Wastewater, Method 9222D, 24 hour Membrane Filter (MF) procedure.

In this method, samples are filtered using varying volumes to establish fecal coliform plate densities in the range of 20 and 60 colonies. The filtered samples are incubated for 24 ± 2 hours at 44.5 ± 0.2°C. The colonies produced by fecal coliform bacteria are various shades of blue. The colonies are counted with a low power microscope or other optical device.

A minimum of two different volumes of sample will be filtered for each bacteria analysis. Suggested volumes to be filtered for the analyses are presented in Table 11. These volumes will provide results ranging from 1 to 4,000 CFU/100mL for fecal coliform bacteria in stormwater samples. At the discretion of the laboratory analyst, sample volumes may be adjusted if bacteria concentrations differ from those anticipated.

Table 11. Water Sample Volumes to be Filtered for Fecal Coliform Bacteria Analyses.

Filter Volume (mL)	Concentration Range (CFU/100mL)	
	Quantifiable Range[a]	Non-estimated Values[b]
Samples collected during non-storm events		
10	10 – 2,000	200 – 600
100	1 – 200	20 – 60
Samples collected during storm events		
5	20 – 4,000	400 – 1,200
50	2 – 400	40 – 120

[a] Quantifiable range based on a range of 1 to 200 colonies per culture plate according to typical analytical capabilities.
[b] Non-estimated rangee based on an optimum range of 20 to 60 colonies per culture plate according to the method reporting requirements.

Sample Quantification

The quality control objectives established for the fecal coliform membrane filter procedure (Standard Methods method 9222-D in APHA et al. 1998) are to filter a sample volume that yields an ideal range of 20 to 60 fecal coliform positive colonies on a culture plate to obtain statistically reliable results, and for not more than 200 colonies of all bacteria types to be present on a culture plate to assure that the results are not underestimated due to crowding (e.g., merged colonies or false negatives). The analysis method also provides guidance for calculation of fecal coliform density as follows:

- If one of the plate counts is between 20 and 60, then calculate the density for the sample volume yielding a plate count in this ideal range.
- If duplicate sample volumes were analyzed then calculate the average density for both analyses.
- If all counts are outside the ideal range then calculate the average density for all sample volumes analyzed, excluding counts greater than 200, by dividing the sum of the plate counts by the sum of the sample volumes.
- If no plate counts less than 200 were obtained, but a plate had a total bacterial colony count greater than 200, then report the density as greater than the value associated with this plate count.

If average densities of two plates are calculated, the following equation will be used:

$$AverageDensity = \frac{(CFU_1 + CFU_2)}{(Vol_1 + Vol_2)} x100$$

Where: CFU_1 = number of colonies on plate 1
CFU_2 = number of colonies on plate 2
VOL_1 = volume filtered plate 1
VOL_2 = volume filtered plate 2

Quality Control

To ensure the data quality objectives for this study are met, the project team will implement the procedures specified in the following subsection for field and laboratory quality control, and summarized in Table 12.

Table 12. Summary of Field and Laboratory Quality Control Procedures.

Method	Parameter	Method Blanks	Field Splits	Lab Check Standard	Field Duplicate	Matrix Spikes
YSI 55 meter	Temperature (field measurement)	NA	NA	NA	NA	NA
YSI 55 meter	Dissolved oxygen (field measurement)	NA	NA	NA	NA	NA
SM 9222D	Fecal coliform	1/sampling event	1/sampling event	N/A	1/sampling event	N/A

NA not applicable

Field

Station Information

Station coordinates obtained by GPS, or descriptions will be accurately recorded. If GIS resources are available, they will be plotted on a Geographic Information System (GIS) map and compared to the expected location and features. The need for adjustments or new coordinates will be made on a case-by-case basis.

Field Notes

The notes from each field run will be tabulated and compared to chain-of-custody forms and laboratory results for completeness and accuracy. Any problems and associated corrective actions will be recorded. Any unresolved problems will be flagged and discussed in the data report.

Fecal Coliform Bacteria

Total variability for field sampling and laboratory analysis will be assessed by collecting field splits and duplicates samples for each sampling event. Bacteria samples tend to have a high RPD between replicates compared to other water quality analyses. The RPD may also vary based on the order of magnitude of the results.

Laboratory

Fecal Coliform

Routine laboratory quality control procedures will be followed. A method blank, field split and field duplicate will be analyzed for each sampling event.

Data Management Procedures

This section describes the procedure that will be used to ensure that all data generated for the City of Monroe 2015 Fecal Coliform Bacteria Monitoring Program are accurately entered into the project database, are securely stored in a manner that facilitates data analysis, and are properly archived.

Time, location, weather conditions, and other observations and environmental factors will be recorded at the time of sampling and maintained for public record purposes. Data will be transferred no less than quarterly to a computer spreadsheet to provide a backup copy of hard data and to facilitate information sharing with Ecology and other agencies. At that time, the hard data will be checked for errors. Laboratory worksheets will be filed together and stored in a binder or other organized form.

City staff will be responsible for internal quality control validation and for properly transferring and reporting data to the project manager throughout the project. The project manager may approve data that does not meet data quality objectives above for use with appropriate qualification and consultation.

Audits and Reports

The City of Monroe laboratory, which is an accredited laboratory, will submit data to the project manager as well as any problems with the analyses, corrective actions taken, or changes to the referenced method for correction or action as needed. Data will be reported in a Microsoft© Excel spreadsheet after each monthly sampling event.

In addition to the results spreadsheet, specific Quality Assurance information that will be included in an email from the Laboratory Analyst to the Project Manager includes the following:

- Significant QA problems and recommended solutions
- Data quality assessment in terms of precision, accuracy, representativeness, completeness, comparability, and reporting limits
- Sample estimates and rejections
- Discussion of whether the QA objectives were met, and the resulting impact on decision making
- Limitation on use of the measurement data.

The Project Manager will review the data and data qualifiers monthly to ensure that obvious analytical problems are addressed.

Data will be summarized annually by the Project Manager and reported as part of the Bacterial Pollution Remediation Plan section of the Stormwater Management Plan. Data qualifiers will be explained in all reports as needed. Data will be explained in tabular and graphical format. Tables will track seasonal compliance with water quality standards using a dry season period of May through September. Data will be submitted on an annual basis to Ecology's EIM system.

Data Verification, Validation, and Review

This section defines data review, verification, and validation and then presents the methods to be used to verify and validate the data, including the procedures that will be followed if DQOs are not met.

Data Review, Verification, and Validation

For the purposes of this document, data verification is a systematic process for evaluating performance and compliance of a set of data to ascertain its completeness, correctness, and consistency using the methods and criteria defined in the QAPP. Validation means those processes taken independently of the data-generation processes to evaluate the technical usability of the verified data with respect to the planned objectives or intention of the project. Additionally, validation can provide a level of overall confidence in the reporting of the data based on the methods used.

All data obtained from field and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the data quality objectives which are listed in the Quality Objectives section. Only those data which are supported by appropriate quality control data and meet the measurement performance specification defined for this project will be considered acceptable and used in the project.

The Project Manager is responsible for ensuring that field data are properly reviewed and verified for integrity. The Laboratory Analyst is responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and accuracy, and reviewed for integrity. The Laboratory Analyst is also responsible for validating the data. The Project Manager is responsible for entering the data in the project database. The Project Manager will be responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format to the project database. Finally, the Project Manager, with the concurrence of the Laboratory Analyst, is responsible for ensuring that all data to be reported meet the objectives of the project and are suitable for reporting.

Verification and Validation Methods

All data will be verified to ensure they are representative of the samples analyzed and locations where measurements were made, and that the data and associated quality control data conform to project specifications. The staff and management of the respective field, laboratory, and data management tasks are responsible for the integrity, validation and verification of the data each task generates or handles throughout each process. The field and laboratory tasks ensure the verification of raw data and electronically generated data. This section presents the data verification and validation procedures for fecal coliform bacteria data.

Laboratory data will be verified and validated within two days of analysis. This review will be performed to ensure that all data are consistent, correct, and complete, and that all required quality control information has been provided. Quality control reviews, and any problems and corrective actions, will be summarized in an email. Values associated with minor quality control problems will be considered estimates and assigned J qualifiers. Values associated with major quality control problems will be rejected and qualified R. Estimated values may be used for evaluation purposes, whereas rejected values will not be used. The following sections describe the data validation procedures for these quality control elements:

- Completeness
- Methodology
- Holding times
- Blanks
- Field duplicates and splits
- Fecal coliform bacteria enumeration

Completeness

Completeness will be calculated by dividing the number of valid values by the total number of values. Samples may be recollected if completeness is less than 95 percent.

Methodology

Methodology will be assessed by examination of the field notebook and laboratory reports for any deviations from this sampling and analysis plan. Unacceptable deviations will result in rejected values (R) and will be corrected for future analyses.

Holding Times

Maximum holding times will be assessed by comparing analytical dates to sample collection. Values that exceed the maximum holding time (e.g., 8 hours for fecal coliform bacteria) will be considered estimates (J), whereas severe exceedances (e.g., greater than 24 hours for fecal coliform bacteria) will result in rejected values (R).

Blanks

One preparation blank consisting of clean laboratory water will be analyzed with each sample batch. Sample values that are less than 5 times a detected blank value will be considered estimates (J).

Field Duplicates and Splits

Precision of filed duplicate/split samples and results will be presented on each laboratory worksheet. One field duplicate and one field split sample will be analyzed with each batch of samples. In this case, a batch represents the samples collected during one sampling event.

Two levels of precision for duplicate/split analyses will be evaluated using reported values. The relative percent difference (RPD) of laboratory and field duplicates will be less than or equal to 35 percent for values that are greater than 5 times the reporting limit, and ± 2 times the reporting limit for values less than or equal to 5 times the reporting limit. Results exceeding the quality control objectives will be noted by the Laboratory Analyst, and associated values will be flagged as estimates (J).

Fecal Coliform Bacteria Enumeration

Raw data for all fecal coliform bacteria analyses will be reviewed to evaluate whether the plate counts were properly used to calculate the results and the quality control objectives established by the method were met (see Laboratory Procedures). Fecal coliform bacteria results for this project will be qualified as estimates (J) if the plate count is outside the ideal range of 20 to 60 colonies, and will be qualified as greater than (>) if the plate count exceeds 200 colonies and is reported as too numerous to count (TNTC).

Data Quality (Usability) Assessment

Data quality assessment for this project will include applying the data quality objectives and sampling design, preparing summary statistics and graphs, and drawing conclusions from the data. Geometric mean analysis will be compared to water quality criteria (see Appendix B for method of calculation).

References

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Ecology. 2003. Lower Snohomish River Tributaries Fecal Coliform Bacteria Total Maximum Daily Load: Detailed Implementation Plan. Washington State Department of Ecology, Water Quality Program. Publication No. 03-10-031. June 2003.

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Appendix A

Field Data Collection Sheet and Laboratory Worksheet

Field Data Collection Spreadsheet

Date	Time	Station ID	Sample #	Comments

City of Monroe Water Quality Lab

Stormwater/Surface Water TMDL Study

Date: ____________

Sample Site	Sample Letter	Mls plated	CFU / plate	CFU /100 ml	Average
Blank					
Al Borlin Split					
Al Borlin Split					
Al Borlin Duplicate					
Eagles Park					
Lake Tye Outfall					
Cripple Creek					
French Creek					
Lake Tye Inlet					
Lords Lake Outfall					
Southwest Ditch					

Appendix B

Instructions for Calculating Seasonal Means

Figuring out Seasonal Means and 90th percentile values*

* note: when you have two values for one day, take the arithmetic mean of the two values and use that number for your geometric mean and 90th percentile calculations. Remember to remove the asterisks so EXCEL will know that it is working with a number.

Step 1: Put your data in the following spreadsheet. If your date distribution changes, then you need to change the month # by hand.

Month #	Date	Q-1 Data Analysis Value 1	Value 2	Arithmetic Mean	Season
4	4/3/2003	200	230	215	wet
5	5/1/2003	530		530	dry
6	6/5/2003	1200	270	735	dry
7	7/3/2003	660	570	615	dry
8	7/31/2003	110	110	110	dry
9	9/4/2003	90		90	dry
10	10/1/2003	220		220	dry
11	11/5/2003	42		42	wet
12	12/3/2003	1300		1300	wet
1	1/8/2004	700		700	wet
2	2/6/2004	100	120	110	wet
3	3/3/2004	460	100	280	wet

Step 2: Select data from cells A28 through F39 then Sort on Column F (Season)

Month #	Date	Q-1 Data Analysis Value 1	Value 2	Arithmetic Mean	Season
4	4/3/2003	200	230	215	wet
5	5/1/2003	530		530	dry
6	6/5/2003	1200	270	735	dry
7	7/3/2003	660	570	615	dry
8	7/31/2003	110	110	110	dry
9	9/4/2003	90		90	dry
10	10/1/2003	220		220	dry
11	11/5/2003	42		42	wet
12	12/3/2003	1300		1300	wet
1	1/8/2004	700		700	wet
2	2/6/2004	100	120	110	wet
3	3/3/2004	460	100	280	wet

Step 3: Calculate compliance with state standards on each seasonal data set.

Q-1 Data Analysis

Month #	Date	Value 1	Value 2	Arithmetic Mean	Season
5	5/1/2003	530		530	dry
6	6/5/2003	1200	270	735	dry
7	7/3/2003	660	570	615	dry
8	7/31/2003	110	110	110	dry
9	9/4/2003	90		90	dry
10	10/1/2003	220		220	dry
		geometric mean =		284	
4	4/3/2003	200	230	215	wet
11	11/5/2003	42		42	wet
12	12/3/2003	1300		1300	wet
1	1/8/2004	700		700	wet
2	2/6/2004	100	120	110	wet
3	3/3/2004	460	100	280	wet
		geometric mean =		252	

Step 4: Determine compliance with 90th percentile standard….. Given that the seasonal sample size is 6, then our 303(d) listing policy suggests that at least 3 of your values need to be over 200 cfu/100 mL in order to show that water quality standards are not being met. If this condition is not met and some of your samples are still on the high side, then there is insufficient data to determine compliance unless an equation is used. I prefer to wait until more samples are collected.

In the case of Q-1, both seasons are not meeting standards. I have included an equation for you to use in the future in the table below.

Q-1 Data Analysis

Month #	Date	Value 1	Value 2	Arithmetic Mean	Season
5	5/1/2003	530		530	dry
6	6/5/2003	1200	270	735	dry
7	7/3/2003	660	570	615	dry
8	7/31/2003	110	110	110	dry
9	9/4/2003	90		90	dry
10	10/1/2003	220		220	dry
		geometric mean =		284	
		90th percentile =		675	
4	4/3/2003	200	230	215	wet
11	11/5/2003	42		42	wet
12	12/3/2003	1300		1300	wet
1	1/8/2004	700		700	wet
2	2/6/2004	100	120	110	wet
3	3/3/2004	460	100	280	wet
		geometric mean =		252	
		90th percentile =		1000	

Appendix C

Calibration and Use of the YSI 55 Portable DO Meter

Be certain to read the manual for the YSI 55 DO meter and understand the instrument's operation before proceeding. The meter must be calibrated each time before use. Calibration should take place at a temperature within ± 10°C of the sample temperature.

1. Ensure sponge inside calibration chamber is wet.
2. Inspect probe membrane. It should be clean, tight and shiny.
3. Gently wipe any moisture from membrane.
4. Insert probe into calibration chamber.
5. Turn instrument on by pressing ON/OFF button.
6. Wait for DO and temperature readings to stabilize (15 minutes or longer).
7. To enter the CALIBRATION MENU use two fingers to press and release both the UP ARROW and DOWN ARROW buttons at the same time.
8. The LCD will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude. (Example: entering 12 here indicates 1200 feet).
9. Press ENTER button.
10. CAL should now be displayed in the lower left of the screen.
11. The calibration value should be displayed in the lower right of the screen.
12. A "pre-calibration" DO reading should in the main display.
13. Make sure the DO reading is stable, then press the ENTER button.
14. You will be prompted to enter the salinity (for our purposes, salinity = 0).
15. Press ENTER button.
16. Remove probe from calibration chamber and read DO in sample.
17. If the sample being analyzed is still, use the probe with a stirring motion. Water must move across the membrane at 1 foot /second for the DO reading to be accurate.